

REMARKS

The Examiner is thanked for his approval of the drawings.

Attached herewith as Attachment "A" are currently amended claims 15 and 40 showing the reference numerals as requested by the Examiner.

The First 35 U.S.C. §103(a) Rejection

Claims 15-20, 25 and 40 stand rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Genov, et al. (USP 5,064,340) and no other reference.

The Office Action states:

"Claims 15-20, 25 and 40 are rejected under 35 U.S.C. §103(a) as being unpatentable over Genov, et al. (USP 5,064,340). Genov discloses 32 is a chip gripper; 12 and 18 levers; toothed wheels and belts (FIG. 5) moves 32, 12 and 18; a plurality of shafts as FIG. 1; a drive mechanism is housed in 38; levers arranged (sic: arranged) with toothed wheels and belts provide various different angles between levers; and 32 is rigidly connected to the opposing end of the second pivoted lever by a shaft, bearings and screws (FIG. 1).

"Genov fails to disclose defining the predetermined gear ratio by the formula $n=360^\circ/\Phi$. It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the predetermined gear ratio by the formula $n=360^\circ/\Phi$, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesh*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980)."

Claim 15 has been amended to distinctly point out that the claimed apparatus is a so-called Die Bonder, ie., an apparatus for mounting semiconductor chips on a substrate. Such a Die Bonder comprises a wafer table which receives a wafer sawn into individual dies (or chips) for presenting a chip at a first location and a displacement means for advancing the substrate and presenting a free substrate place of the substrate at a second location. A lever mechanism

comprising two pivoted levers is swiveled to and fro for gripping a chip presented by the wafer table at the first location and placing it on the free substrate place at the second location.

The wafer table 34 and the displacement means 36 are described in the first paragraph in the section headed "DETAILED DESCRIPTION OF THE INVENTION".

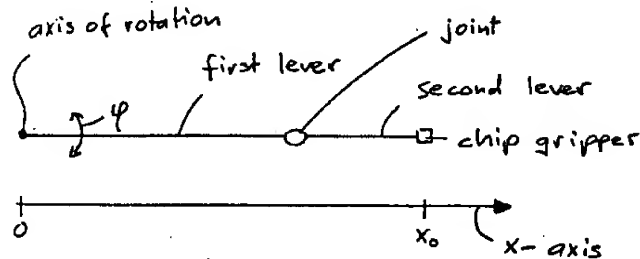
Claim 15 has further been amended to point out that the lever mechanism has only two levers. Figures 1, 2 and 5 all show a lever mechanism with two pivoted levers 10 and 12 or 10' and 12'.

As already explained in the previous responses to the Office Actions, Applicant's invention is related to an apparatus for mounting semiconductor chips. The pick and place system comprising the lever mechanism with the two levers is constructed so that it takes the chips at a specific first location and places them on the substrates at a specific second location. The lever mechanism of the present invention is not able to pick up the semiconductor chips at an arbitrary third location nor to place them at an arbitrary fourth location.

In contrast, Genov, et al. disclose a robot arm which is able to move its hand to an arbitrary location for receiving an object and then to move its hand to another arbitrary location for releasing the object. Genov, et al. disclose a mechanism which allows the movement of the first two levers without changing the orientation of the hand in the space.

Applicant's claimed invention is based on the concept of using two levers which are in extended positions relative to each other when the semiconductor chip is gripped from the wafer table as well as when the semiconductor chip is placed on the substrate. The advantage of this concept is that small orientational errors in the angle of the levers do not result in a positional

error of the chip gripper according to a first order approximation. Such positional errors only result from second order effects. The following drawing illustrates this.



The drawing shows a positional axis designated as the x-axis. The drive mechanism for the first lever rotates the first lever and the angular position of the first lever is designated as angle ϕ . Let's assume that the angle ϕ has the value 0 when the two levers are in extended positions relative to each other (as shown) and that then the chip gripper is located at the position $x=x_0$. The position, x , of the chip gripper as a function of the angle ϕ in the vicinity of $\phi=0$ can be expressed as:

$$x(\phi) = x_0 + \frac{dx}{d\phi}(\phi=0) * d\phi$$

However, at $\phi=0$ we have $dx/d\phi=0$. The derivative $dx/d\phi(\phi=0)$ must disappear for symmetry reasons because the value of the position x must be the same for positive and negative angles $+\phi$ and $-\phi$. So we have the advantage that the x-position of the chip gripper does not depend on occasional over swings of the first lever as long as the over swings are small. This behavior is important for the following reason:

The semiconductor chips must be placed on the substrate with very high accuracy, the accuracy lying in the range of a few microns only. In order to achieve that, the actual position and orientation of the semiconductor chip on the wafer table is measured by a first camera before it is gripped and the actual position of the substrate is measured by a second camera. A positional deviation of the semiconductor chip with regard to its set position on the substrate can be corrected but it is important that the lever mechanism does not introduce additional positional errors. The lever mechanism according to the invention fulfills this requirement to a very high degree.

The predetermined gear ratio defined by the formula $n=360^\circ/\Phi$ expresses the fact that the second lever makes a full rotation of 360° when the first lever is rotated by the angle Φ . This is not just an optimization with regard to the disclosure of Genov, et al. because the construction of Genov, et al. has another purpose, namely the purpose to keep the orientation of its hand fixed in space, independent on the orientation of the levers, thus enabling the so-called r-motion which Applicant explained in great detail in the previous response. If the robot arm of Genov, et al. is modified in that its second lever is rotated according to the predetermined gear ratio defined by the formula $n=360^\circ/\Phi$, where the angle Φ denotes the angle of rotation of the first lever, then the robot arm would no longer allow the r-motion. But this is the basic concept of Genov, et al. Genov, et al. does not anticipate claim 15 for at least the following reasons:

1. Genov, et al. does not disclose a wafer table for presenting semiconductor chips at a first location.

2. Genov, et al. does not disclose a displacement means for advancing the substrates and for presenting a free substrate place at a second location.
3. Genov, et al. fails to disclose the concept of using extended positions of two levers with respect to each other for reducing positional errors.
4. Genov, et al. fails to disclose a predetermined gear ratio defined by the formula $n=360^\circ/\Phi$.
5. Genov, et al. fails to disclose a swiveling of its levers between two defined positions, where the angle of rotation of the first lever is defined by a fixed angle Φ .
6. Genov, et al. cannot be modified to make its second lever rotate with the predetermined gear ratio defined by the formula $n=360^\circ/\Phi$ with respect to the rotation of the first lever because this would destroy its ability to perform the r-motion.

Applicant believes that the new limitations clearly distinguish the claimed apparatus from a robot arm like Genov, et al.'s.

The Second 35 U.S.C. §103(a) Rejection

Claims 21-24 and 26-39 stand rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Genov, et al. (USP 5,064,340) in view of Parker (USP 5,934,147).

The Office Action states:

“Claims 21-24 and 26-39 are rejected under 35 U.S.C. §103(a) as being unpatentable over Genov, et al. (USP 5,064,340) in view of Parker (USP 5,934,147). Genov fails to disclose delimiters and 1:3 gear ratio.

“Parker discloses FIG. 3 shows delimiters thereby limiting the rotational movement of the gripper to allow for picking up heavy or odd size electronic components at certain locations of the apparatus’ reach without manipulating any one of the levers.

“It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify Genov by providing delimiters, as taught by Parker, for the purpose of limiting the rotational movement of the gripper to allow for picking up heavy or odd size electronic components at certain locations of the apparatus’ reach without manipulating any one of the levers.

“At the time the invention was made, it would have been an obvious matter of design choice to a person of ordinary skill in the art to provide a gear ratio of 1:3 because Applicant has not disclosed that such gear ratio provides an advantage, is used for a particular purpose, or solves a stated problem. One of ordinary skill in the art, furthermore, would have expected Applicant’s invention to perform equally well with the gear and toothed belt system as taught by Genov because the outcome of the apparatus is the same.”

Applicant has demonstrated above why the independent claims upon which claims 21-24 and 26-39 are based are allowable. Accordingly, these claims are allowable as well.

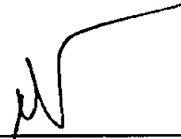
Request for Allowance

As each of the Examiner's rejections have been addressed herein, early favorable consideration of this Amendment is earnestly solicited and Applicant requests that the Examiner enter this amendment and pass claims 15-40 to issue.

If, in the opinion of the Examiner, an interview would expedite the prosecution of this application, the Examiner is invited to call the undersigned attorney at the number indicated below. The Commissioner is hereby authorized to charge any additional fees or credit any overpayment to Deposit Account No. 50-1698.

Respectfully submitted,

THELEN REID & PRIEST, LLP



David B. Ritchie
Reg. No. 31,562

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Thelen Reid & Priest LLP
P.O. Box 640640
San Jose, CA 95164-0640
Tel. (408) 292-5800
Fax. (408) 287-8040

APPENDIX "A"

15. (Currently amended) An apparatus for placing a semiconductor chip on a substrate, comprising:

a wafer table (34) displaceable for presenting a semiconductor chip at a first location (A);
a displacement means (36) for advancing the substrate and presenting a free substrate place of the substrate at a second location (B);

a lever mechanism consisting of a first pivoted lever (10') and a second pivoted lever (12') pivoting in horizontal planes, the first pivoted lever (10') seated at one end on a first shaft (4), said first shaft (4) mounted equidistantly between the first location (A) and the second location (B), the second pivoted lever (12') mounted by means of a second shaft (14) located at another end of said first pivoted lever (10'), a sum of lengths of said first and second pivoted levers equaling a distance from said first shaft (4) to said first location (A) or said second location (B);

a drive (1, 2) coupled to said first shaft (4) for pivoting said first pivoted lever (10') in alternating pivoting directions through an angle Φ of pivoting between a first end position in which said first pivoted lever is directed toward said first location (A) and a second end position in which said first pivoted lever is directed toward said second location (B);

a drive mechanism (5, 6, 7) for rotating said second pivoted lever (12') in an opposite pivoting direction and with a predetermined gear ratio with respect to said first pivoted lever (10'), the drive mechanism (5, 6, 7) coupling said first and second pivoted lever such that the second pivoted lever (12') is in an extended position with respect to said first pivoted lever (10') when

the first pivoted lever (10') is in said first end position or said second end position, the predetermined gear ratio, n , being defined by the formula $n=360^\circ/\Phi$; and

a semiconductor chip gripper (20) seated at an opposing end of said second pivoted lever (12') for gripping the semiconductor chip presented at the first location (A) when the first pivoted lever (10') is in said first end position and for placing the semiconductor chip on the free substrate place when the first pivoted lever (10') is in said second end position.

40. (Currently amended) An apparatus for placing a semiconductor chip on a major surface of a substrate, comprising:

a wafer table (34) displaceable for presenting a semiconductor chip at a first location;

a displacement means (36) for advancing the substrate and presenting a free substrate place of the substrate at a second location;

a lever mechanism consisting of a first pivoted lever (10') and a second pivoted lever (12'), the first pivoted lever (10') seated at one end on a first shaft (4), said first shaft (4) mounted equidistantly between the first location (A) and the second location (B), the second pivoted lever (12') mounted by means of a second shaft (14) located at another end of said first pivoted lever (10'), a sum of lengths of said first and second pivoted levers equaling a distance from said first shaft (4) to said first location (A) or said second location (B), said first and second pivoted levers configured to sweep through a plane parallel to the major surface of the substrate;

a drive (1, 2) coupled to said first shaft (4) for pivoting said first pivoted (10') lever in alternating pivoting directions through an angle of pivoting, Φ , between a first end position in

which said first pivoted lever (10') is directed toward said first location (A) and a second end position in which said first pivoted lever (10') is directed toward said second location (B);

a drive mechanism (5, 6, 7) for rotating said second pivoted lever in an opposite pivoting direction and with a predetermined gear ratio with respect to said first pivoted lever (10'), the predetermined gear ratio, n , being defined by the formula $n=360^\circ/\Phi$, the drive mechanism (5, 6, 7) coupling said first and second pivoted lever (12') such that the second pivoted lever (12') is in an extended position with respect to said first pivoted lever (10') when the first pivoted lever (10') is in said first end position or said second end position; and

a semiconductor chip gripper (20) seated at an opposing end of said second pivoted lever (12') for gripping the semiconductor chip presented at the first location (A) when the first pivoted lever (10') is in said first end position and for placing the semiconductor chip on the free substrate place when the first pivoted lever (10') is in said second end position.